Diverse Noachian Environments

Nili Fossae Trough

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Investigation of Diverse Habitable Noachian Environments (Hydrothermal, alluvial/fluvial, shallow crust/pedogenic)

Sampling and characterizing
- Impact ejecta
- Hesperian volcanics
- Phyllosilicate-bearing infill of Nili Fossae
- Strongly altered Noachian crust
- Unaltered Noachian crust

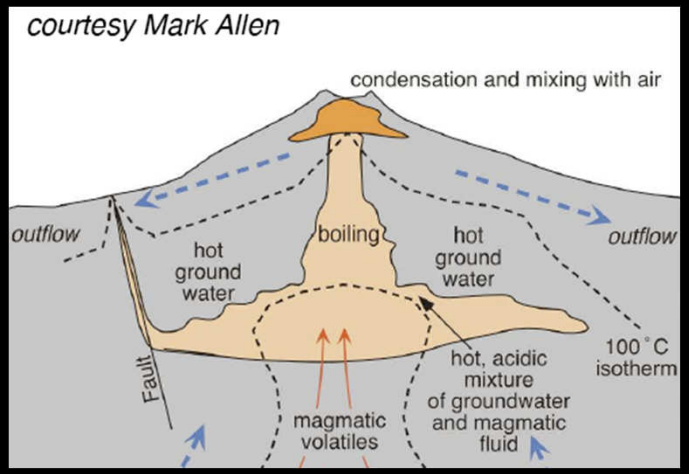
Fully Address E2E SAG Top 3 Objectives
- Life (A1) Planetary Evolution (B1) Water (C1)

Noachian crust enriched in low-Ca pyroxene

Noachian crust enriched in phyllosilicate

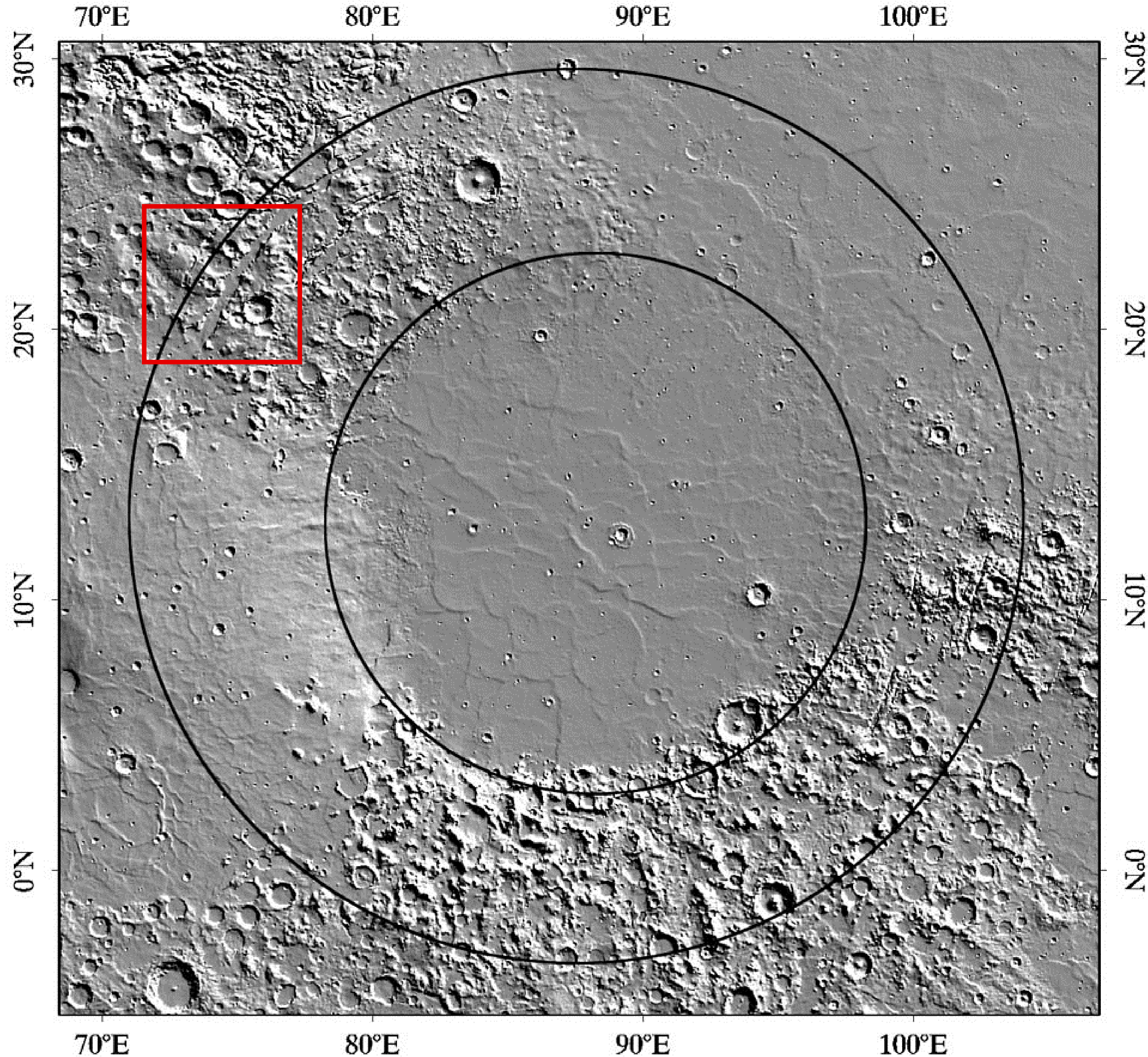
Multiple, Distinct Environments

- Noachian is when phyllosilicate formation was most intense: Access to the source environments
- Hydrothermal systems
  - Fractures as transport pathways for water, mineralization in fractures
  - No mounds, spring deposits, but those are surface features and not expected to survive to the present
- Sedimentary units
  - Infill of trough, formation of sapping channel
  - Regionally, layered units in crater floors, troughs
  - Erosion in go-to site leaves outcrops of remnants of these processes
- Subsurface groundwater or shallow crustal environment
  - Protected from destructive radiation environment
  - Abundant chemical energy sources
  - Fluid flow in the crust/groundwater transported nutrients/energy

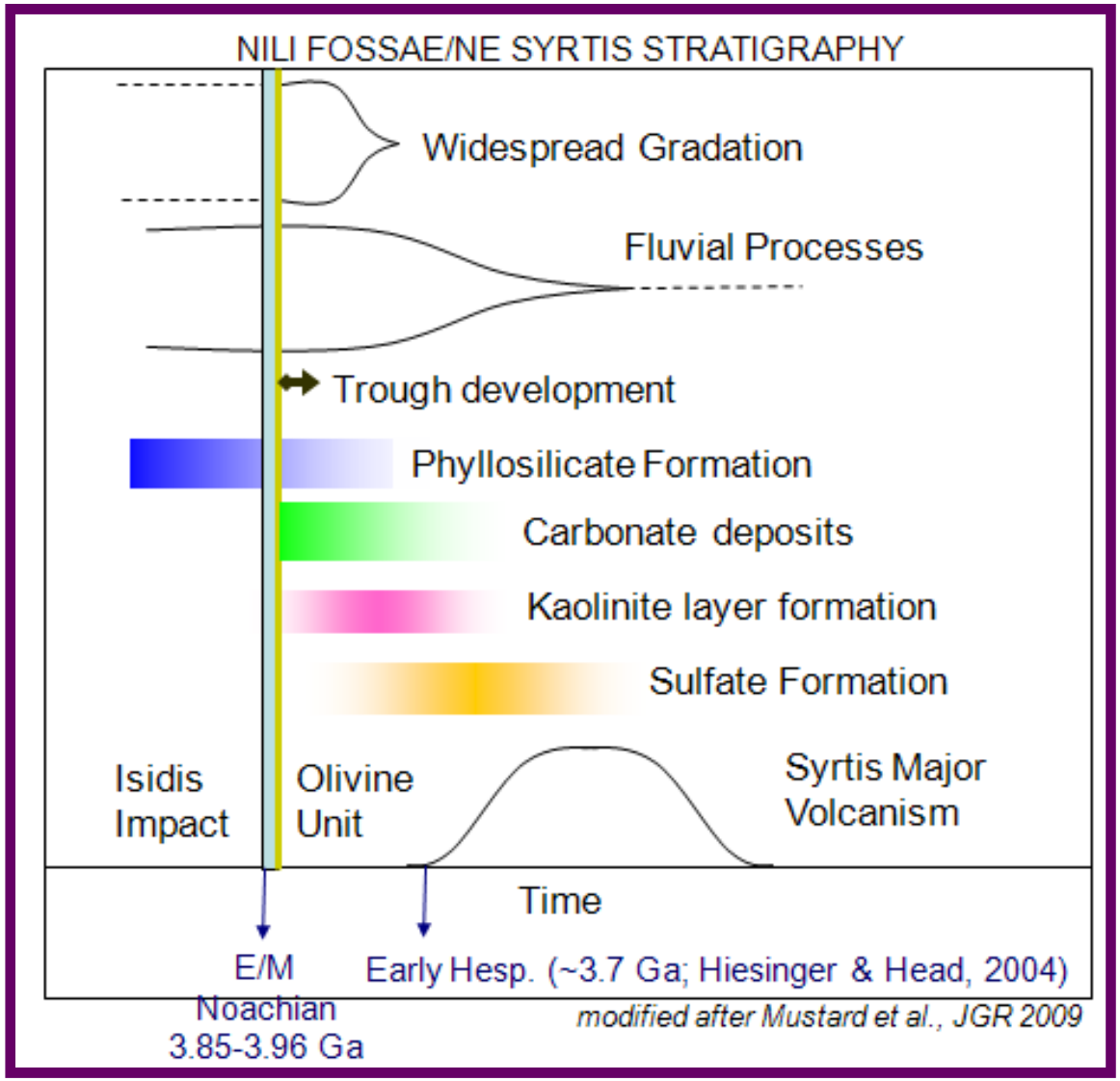


Broad Mars Scientific Objectives

- Noachian Habitable Environments
  - Ancient crustal and genesis region
  - Fluvially transported sediments
  - Hydrothermal systems
- Impact processes
  - Superbly exposed ejecta from 65 km Hargraves crater
  - Ejecta blocks in a phyllosilicate-bearing matrix
  - Transport, fluidization, alteration
- Composition and character of ancient, unaltered crust
- Composition, mineralogy, and texture of Hesperian Syrtis Major lava: A datable surface the time stratigraphic marker
- Traverse the Noachian-Hesperian Boundary
- Phyllosilicate-Transported
- Phyllosilicate-In Place


70°E
80°E
90°E
100°E
30°N
20°N
10°N
0°N

Stratigraphy and Processes in Isidis-Nili Fossae



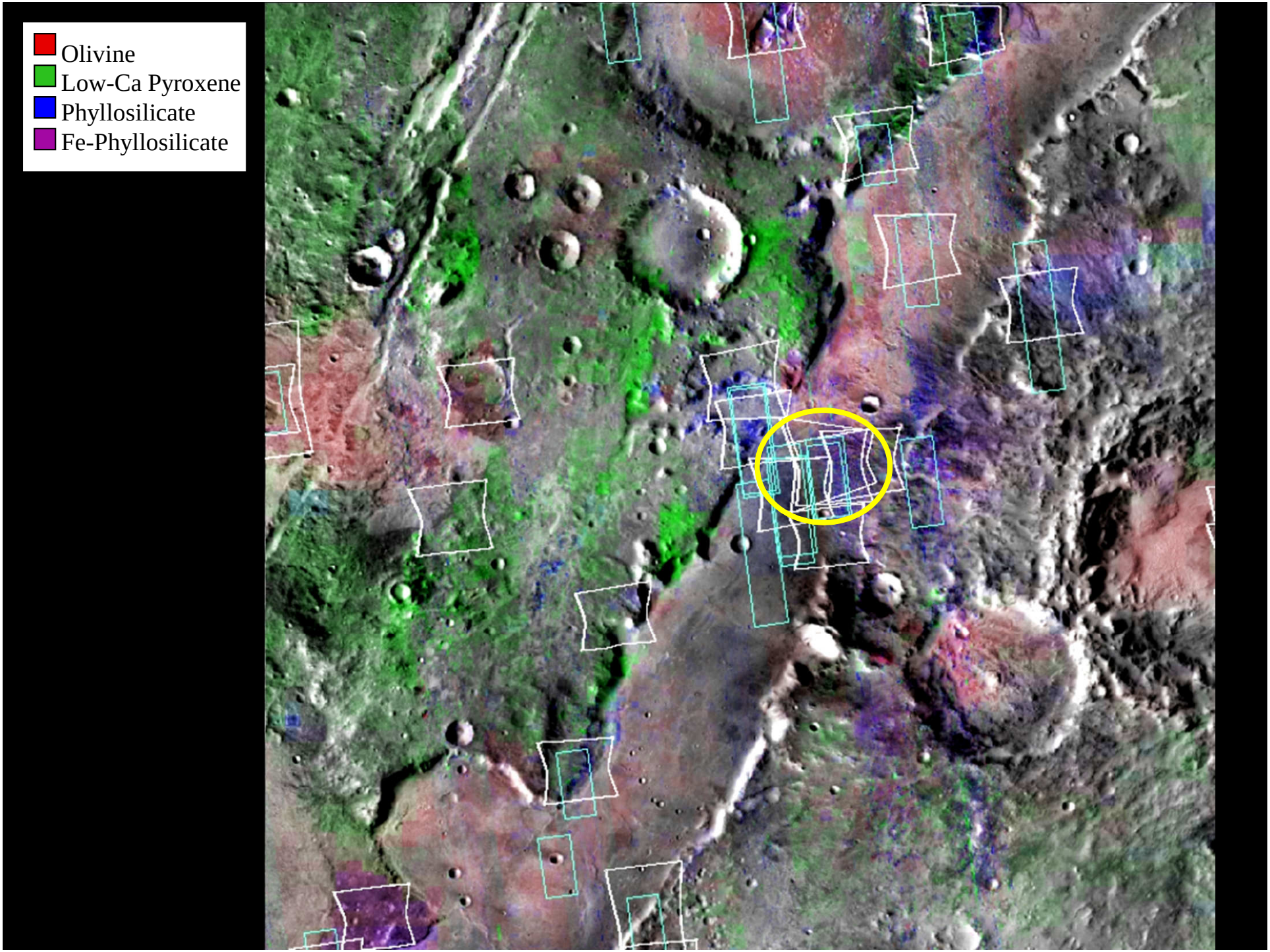
Isidis Basin and Syrtis Major lavas are major time-stratigraphic markers

Significant gradation (sedimentary? aeolian? alluvial?) between Isidis basin formation and Syrtis lava emplacement

Clearly defined wet periods

Nili Fossae Trough

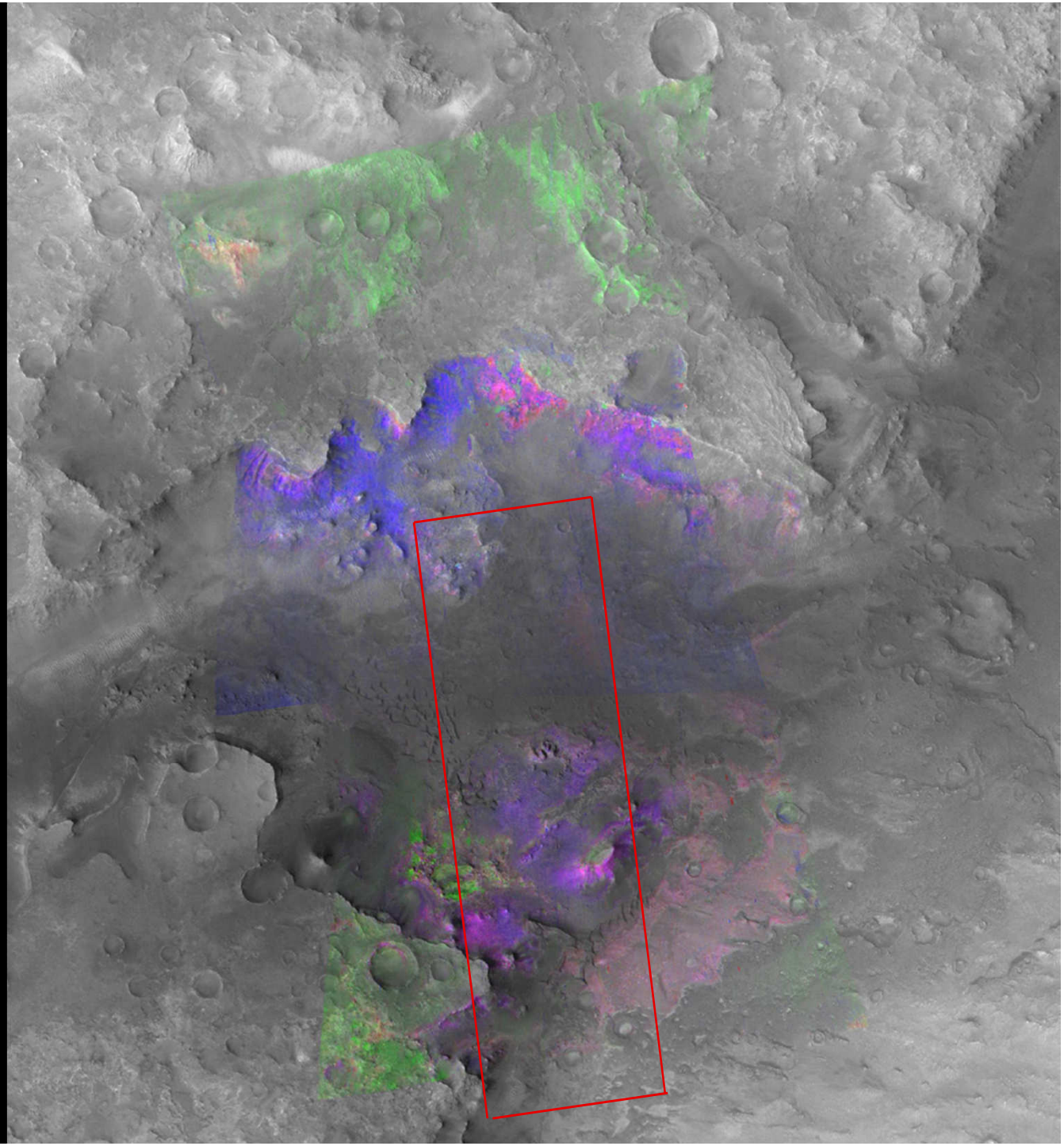
- Diverse Noachian environments present throughout the landing site
- Regional geology, represented in the landing site, indicates sustained interaction of water with the crust over an extended period as a consequence of multiple episodes of distinct character
  - Fe/Mg Phyllosilicates with variation in band position, strength of water absorption
  - Smectite clay transported and deposited in fluvial systems
  - Regional episode of kaolinite formation
  - Carbonate formation in association with olivine
  - Chlorite, zeolite, and hydrated silicate in association with impacts
- The region north east of Syrtis Major was persistently wet and the geologic context for understanding the interaction of water is extraordinarily well preserved and exposed
- The Nili Fossae Trough landing site sits within this region and provides exciting access to a diverse suite of environments

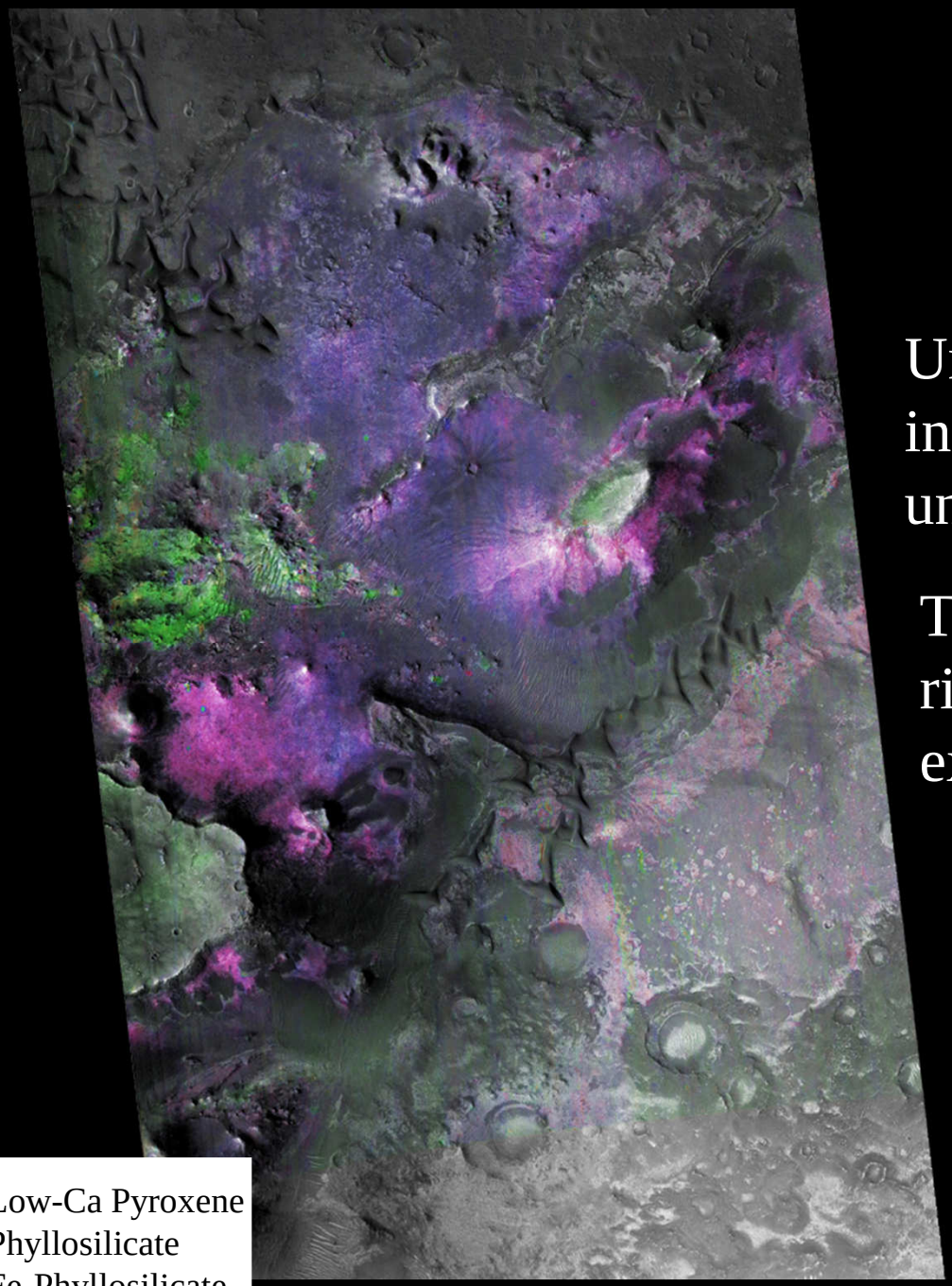

Olivine
Low-Ca Pyroxene
Phyllosilicate
Fe-Phyllosilicate

Olivine
Low-Ca Pyroxene
Phyllosilicate
Fe-Phyllosilicate

CRISM Observations

FRT00007BC8
FRT000064D9





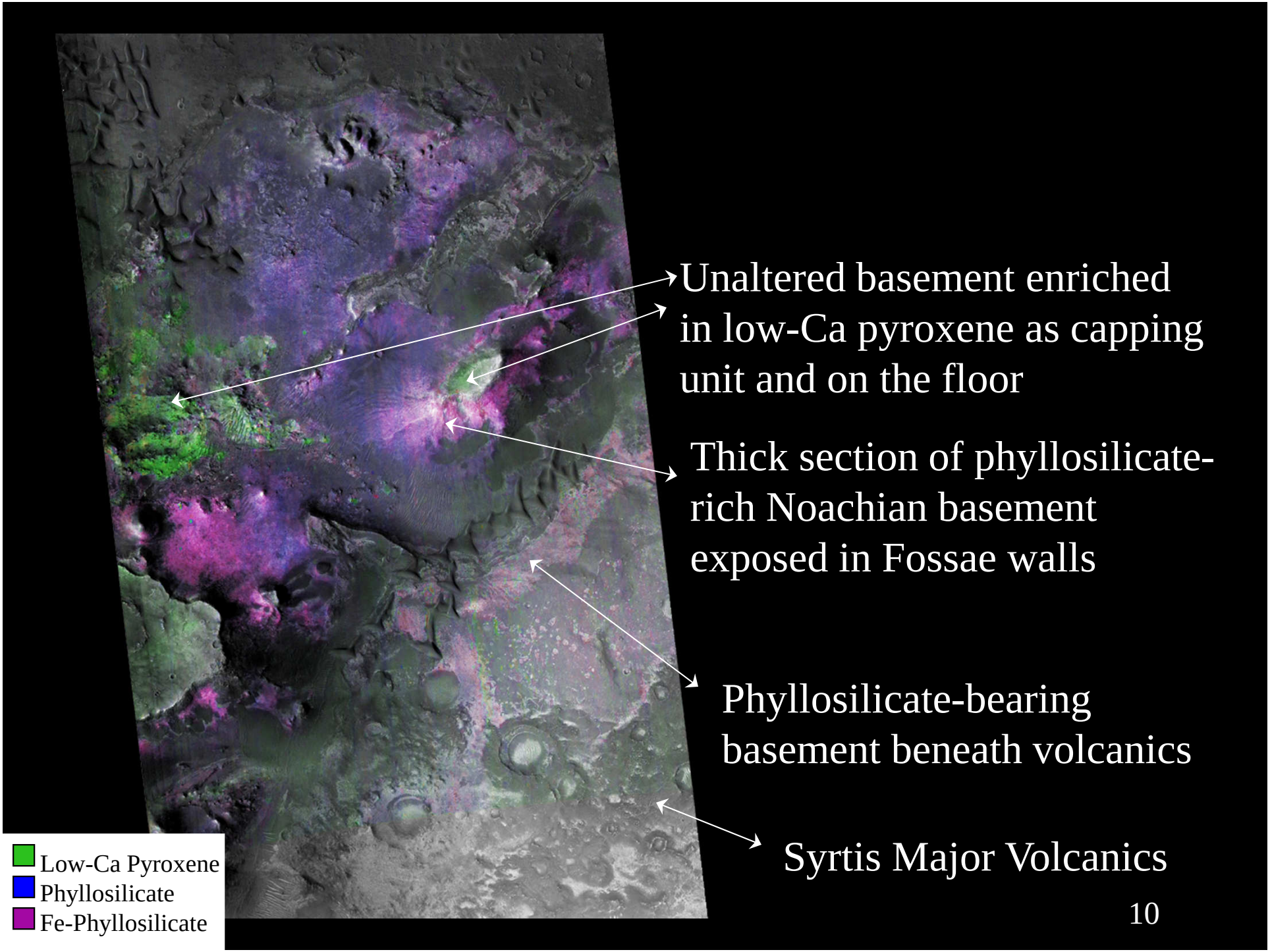
Low-Ca Pyroxene
Phyllosilicate
Fe-Phyllosilicate

Unaltered basement enriched in low-Ca pyroxene as capping unit and on the floor

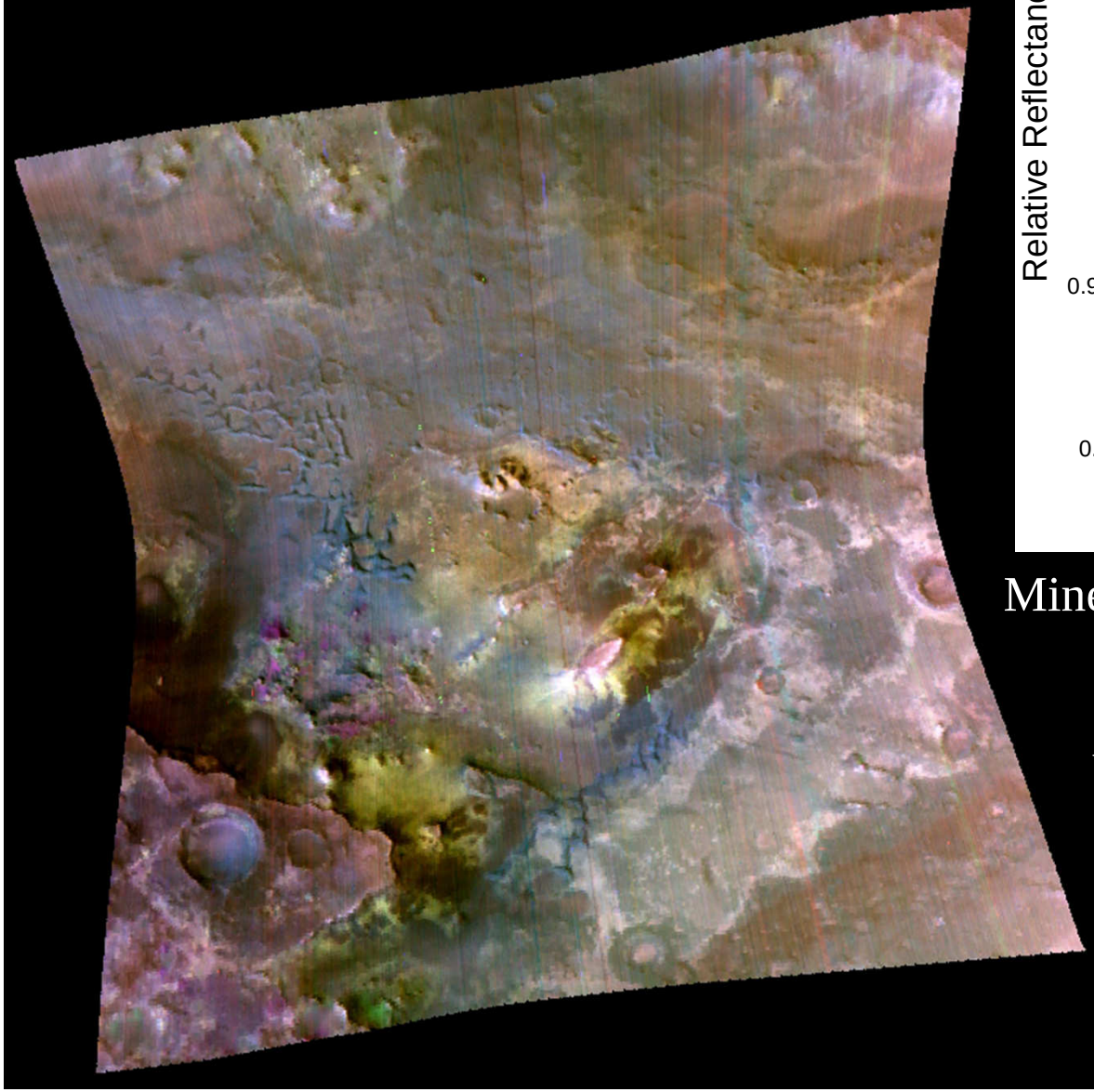
Thick section of phyllosilicate-rich Noachian basement exposed in Fossae walls

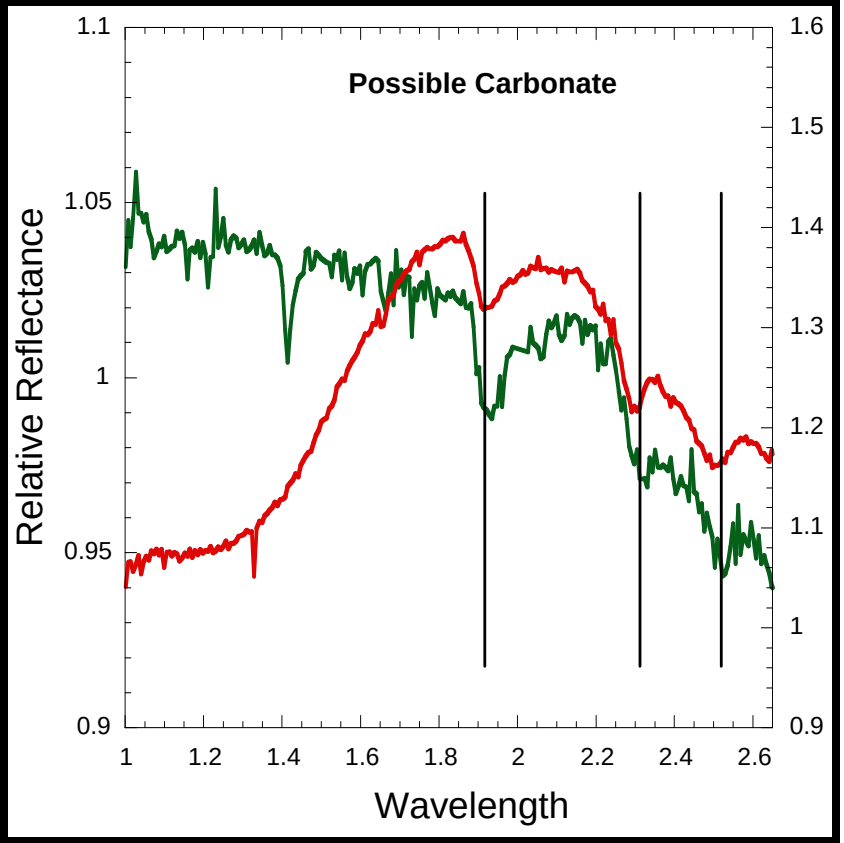
Phyllosilicate-bearing basement beneath volcanics

Syrtis Major Volcanics


Unaltered basement enriched in low-Ca pyroxene as capping unit and on the floor
Thick section of phyllosilicate-rich Noachian basement exposed in Fossae walls
Phyllosilicate-bearing basement beneath volcanics
Syrtis Major Volcanics
Low-Ca Pyroxene
Phyllosilicate
Fe-Phyllosilicate

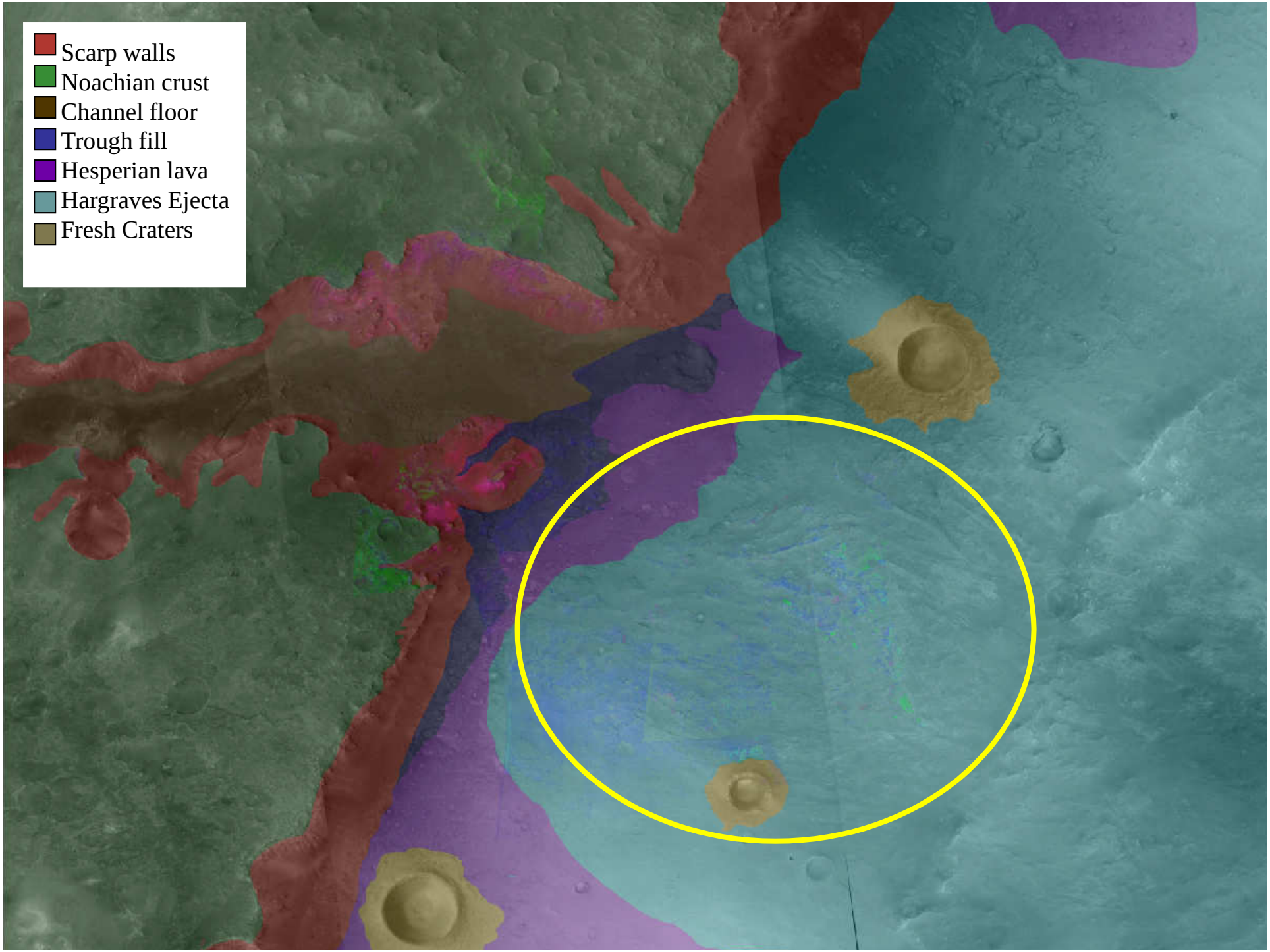
FRT000064D9:
2.4, 1.8, 1.15 µm RGB

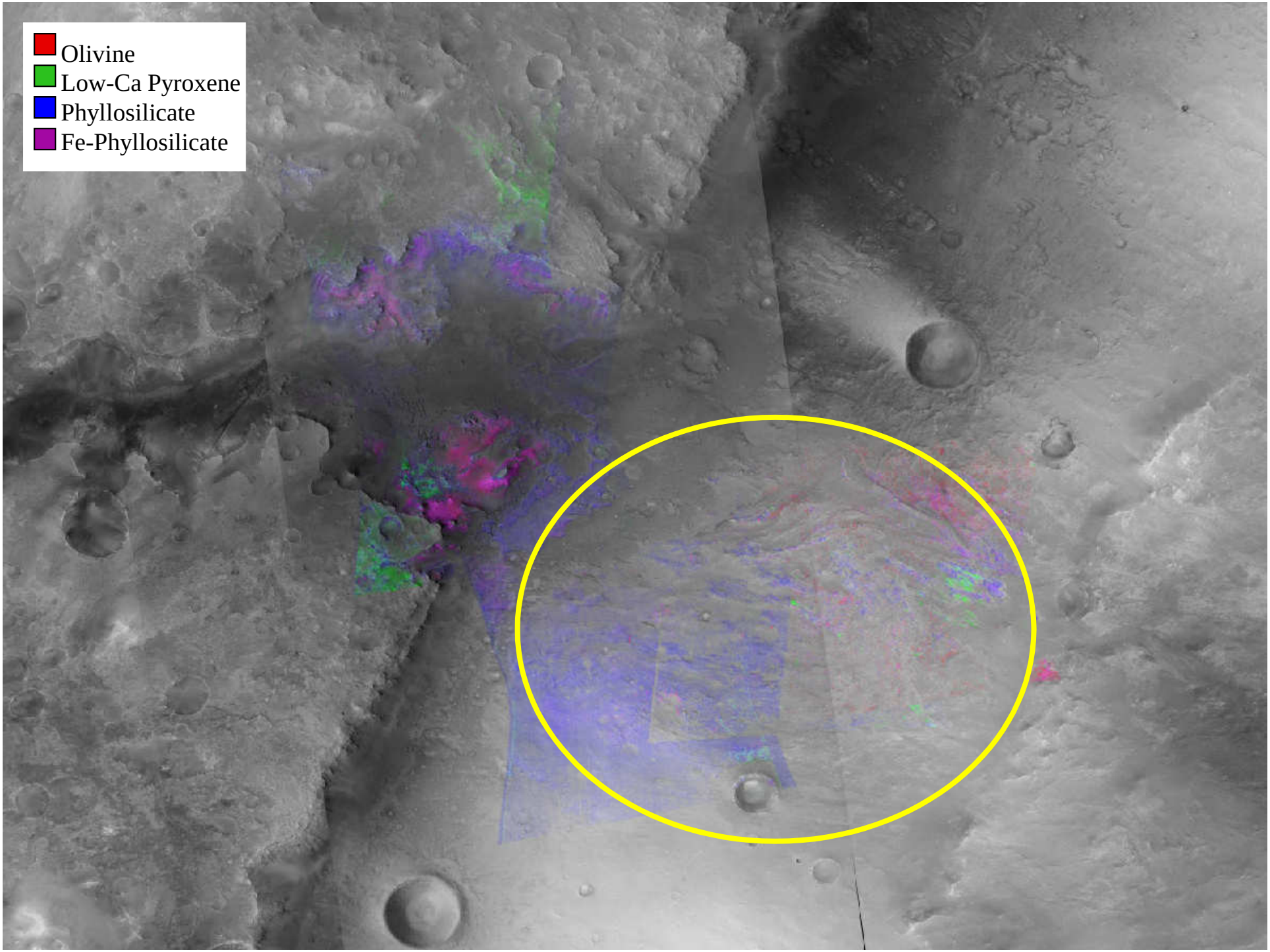


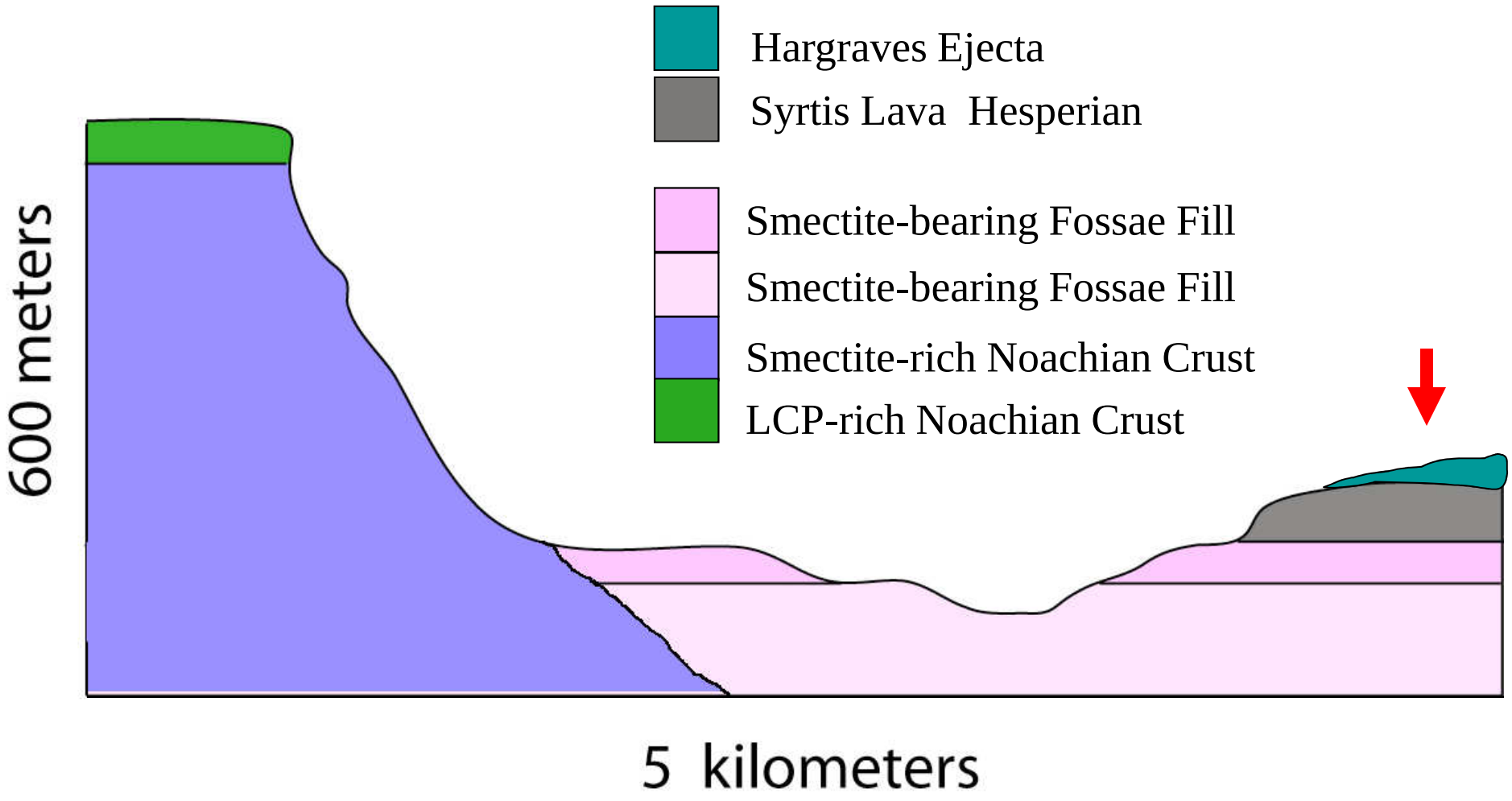


Mineralogy identified

- Fe-oxide and crystaline hematite
- Fe/Mg Smectite with variety of band positions, H_2O content
- Kaolinite
- Carbonate
- Pyroxene (Low and High Ca)
- Olivine


Scarp walls
Noachian crust
Channel floor
Trough fill
Hesperian lava
Hargraves Ejecta
Fresh Craters


Olivine
Low-Ca Pyroxene
Phyllosilicate
Fe-Phyllosilicate



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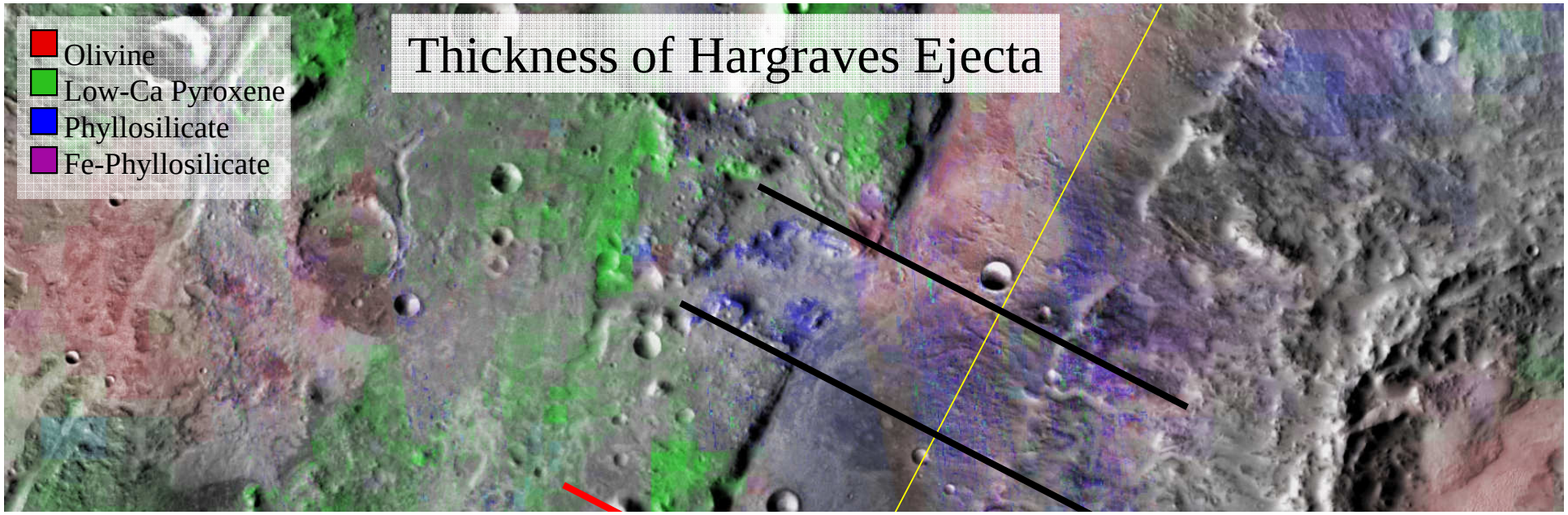
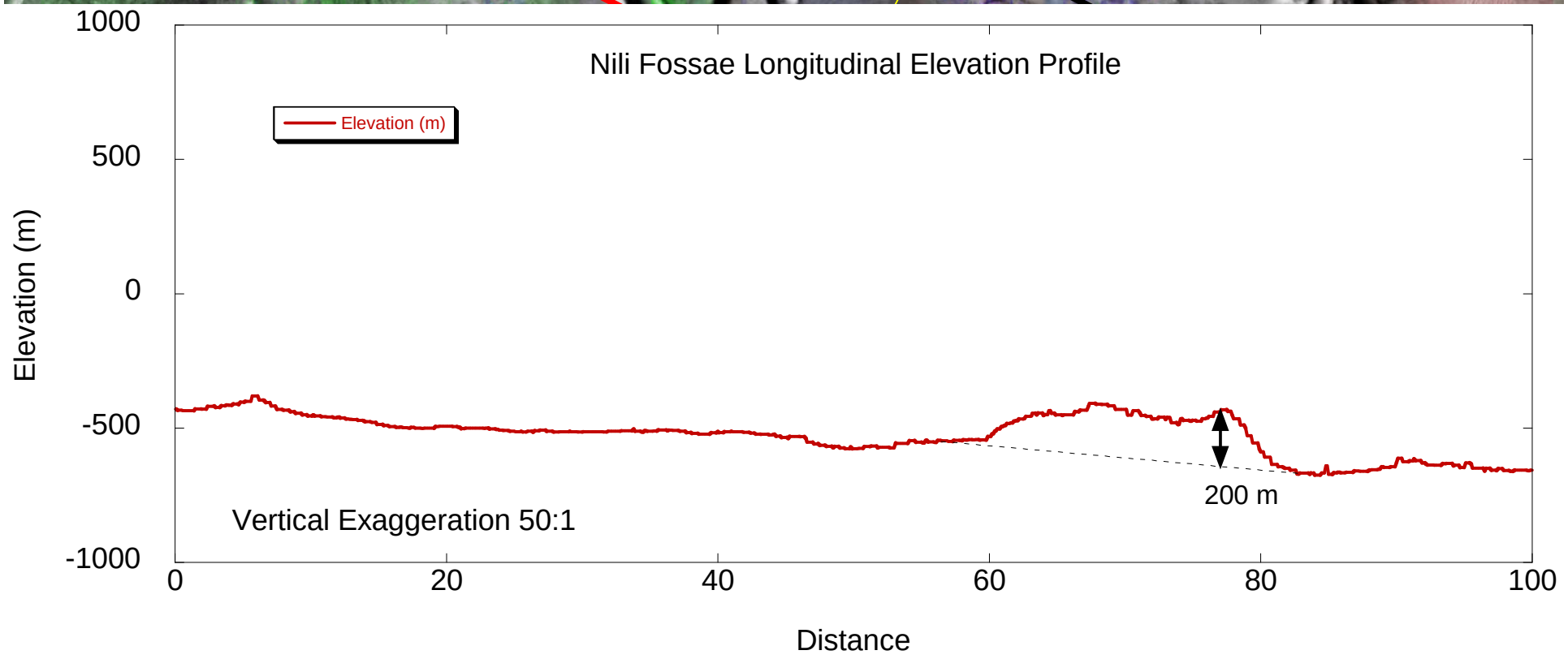
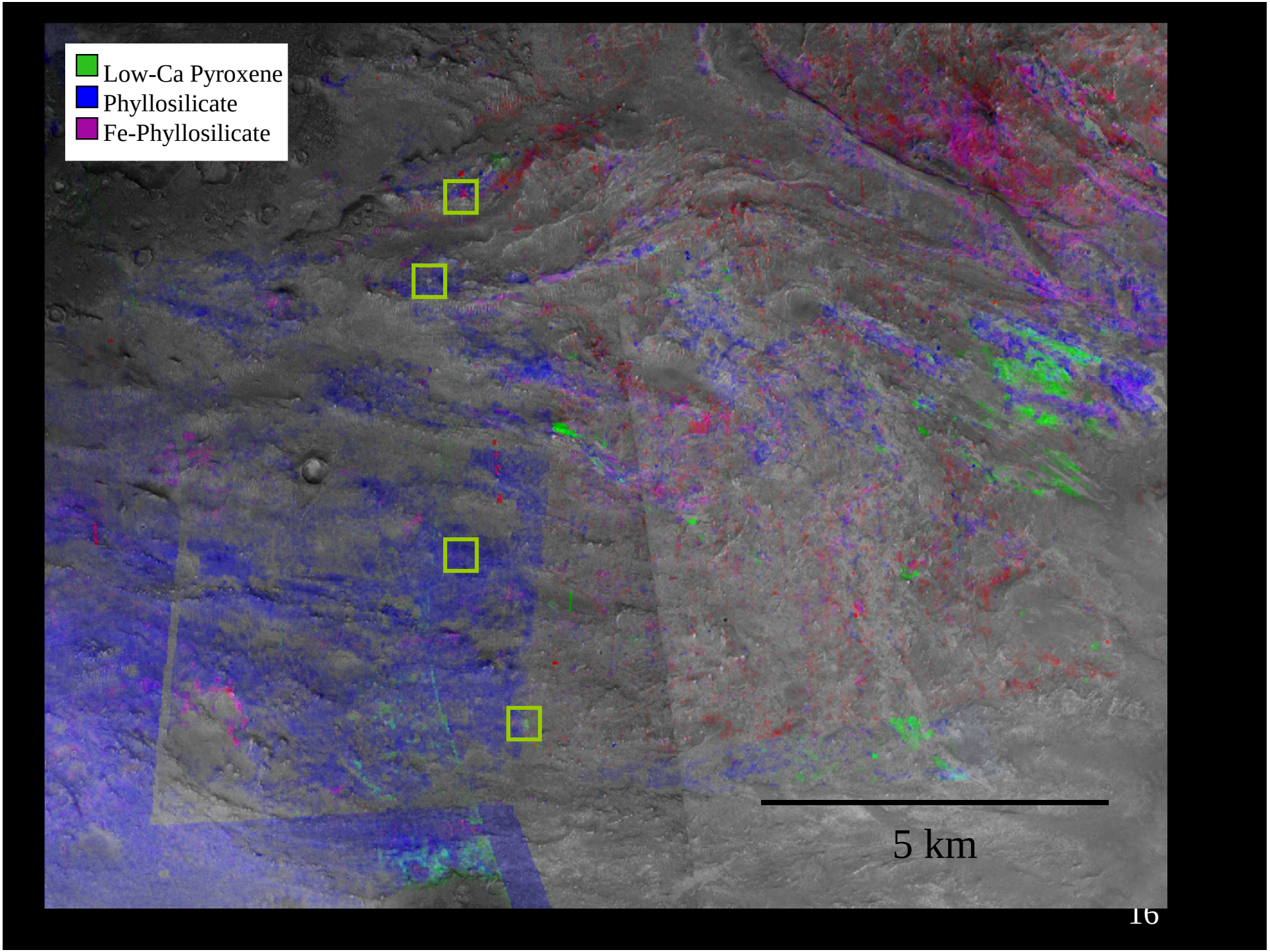
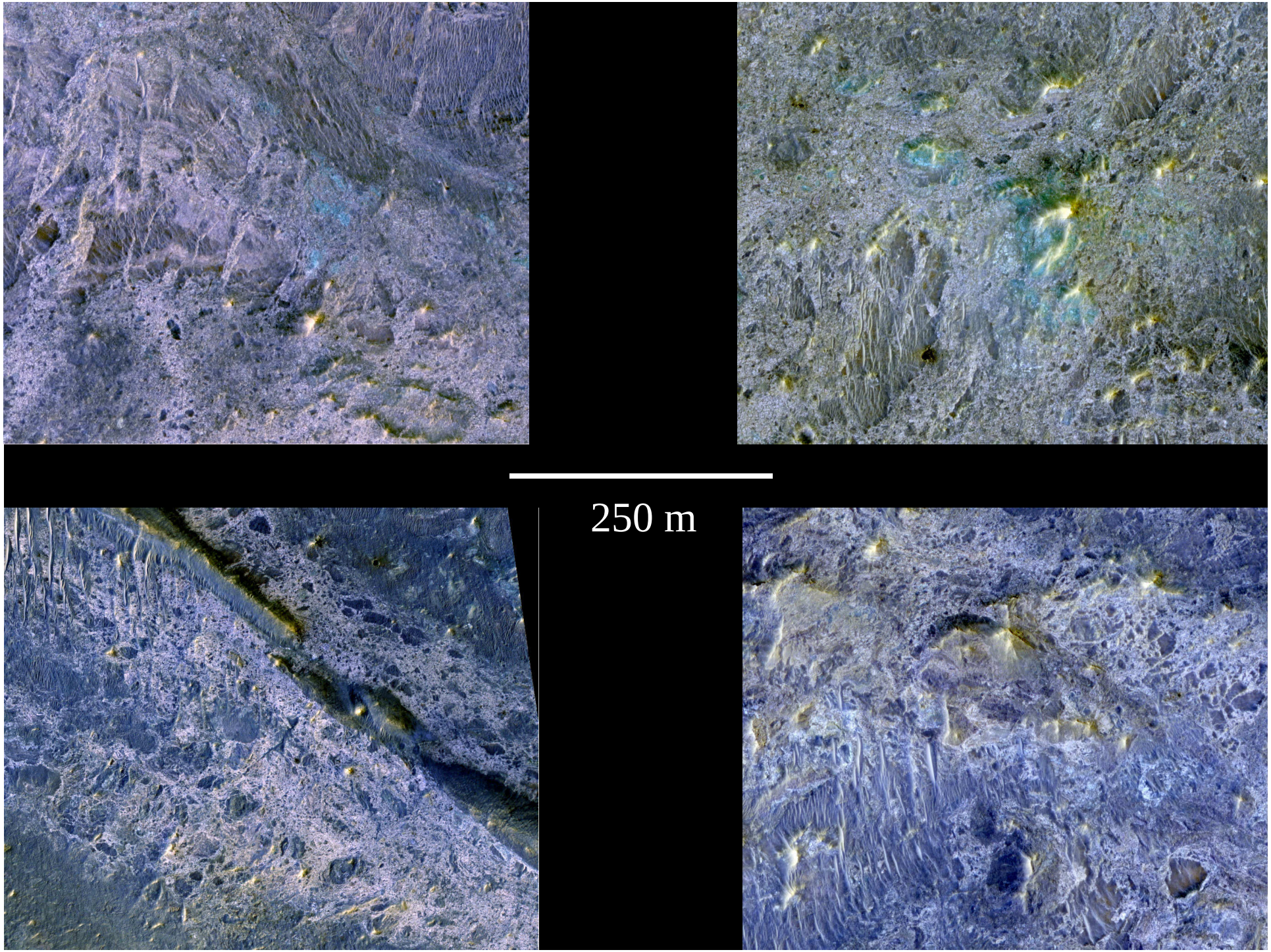
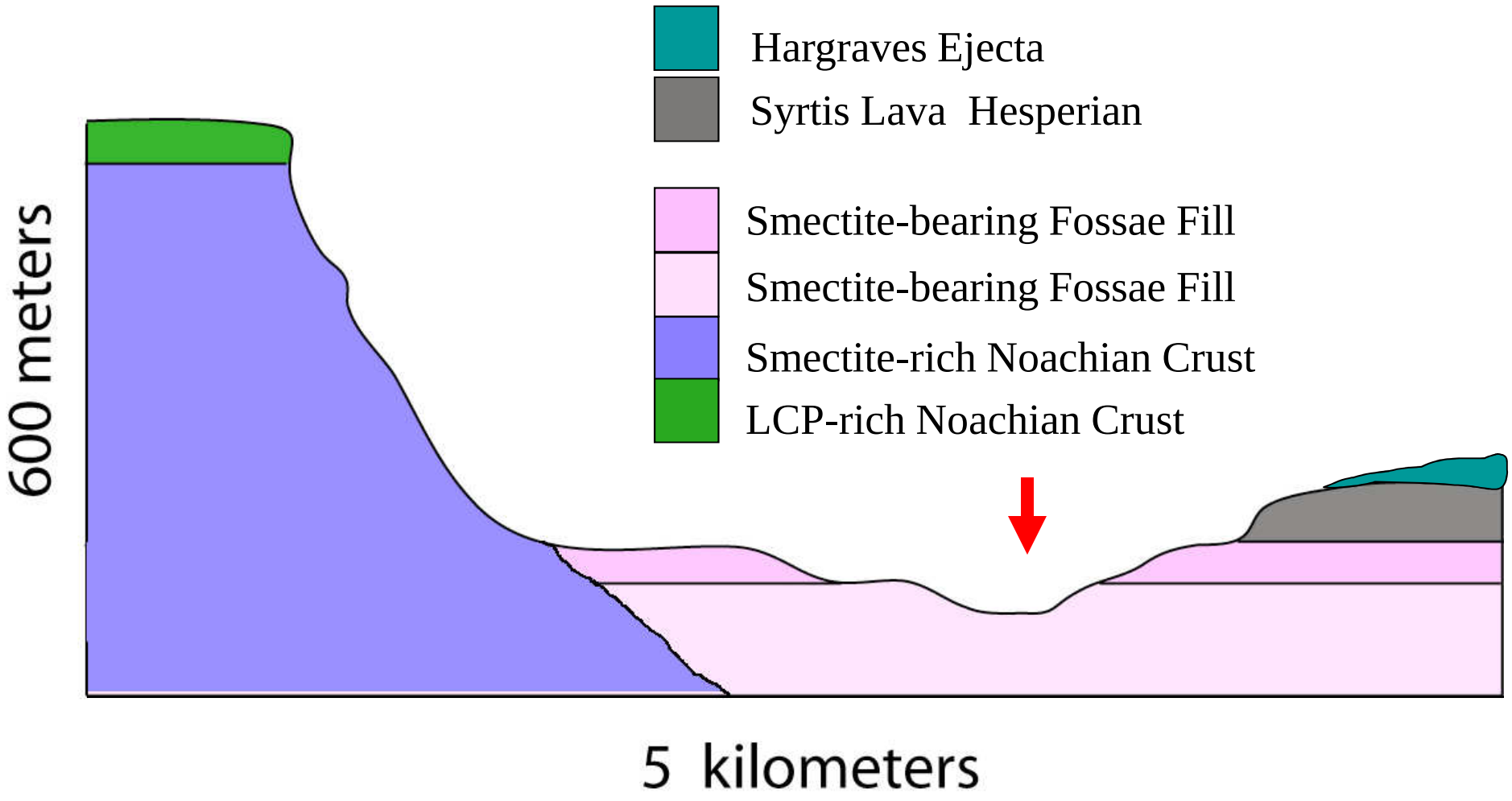

Olivine
Low-Ca Pyroxene
Phyllosilicate
Fe-Phyllosilicate
Thickness of Hargraves Ejecta


Nili Fossae Longitudinal Elevation Profile
Elevation (m)
1000
500
0
-500
-1000
Elevation (m)
200 m
Vertical Exaggeration 50:1
0
20
40
60
80
100
Distance


Low-Ca Pyroxene
Phyllosilicate
Fe-Phyllosilicate
5 km


250 m



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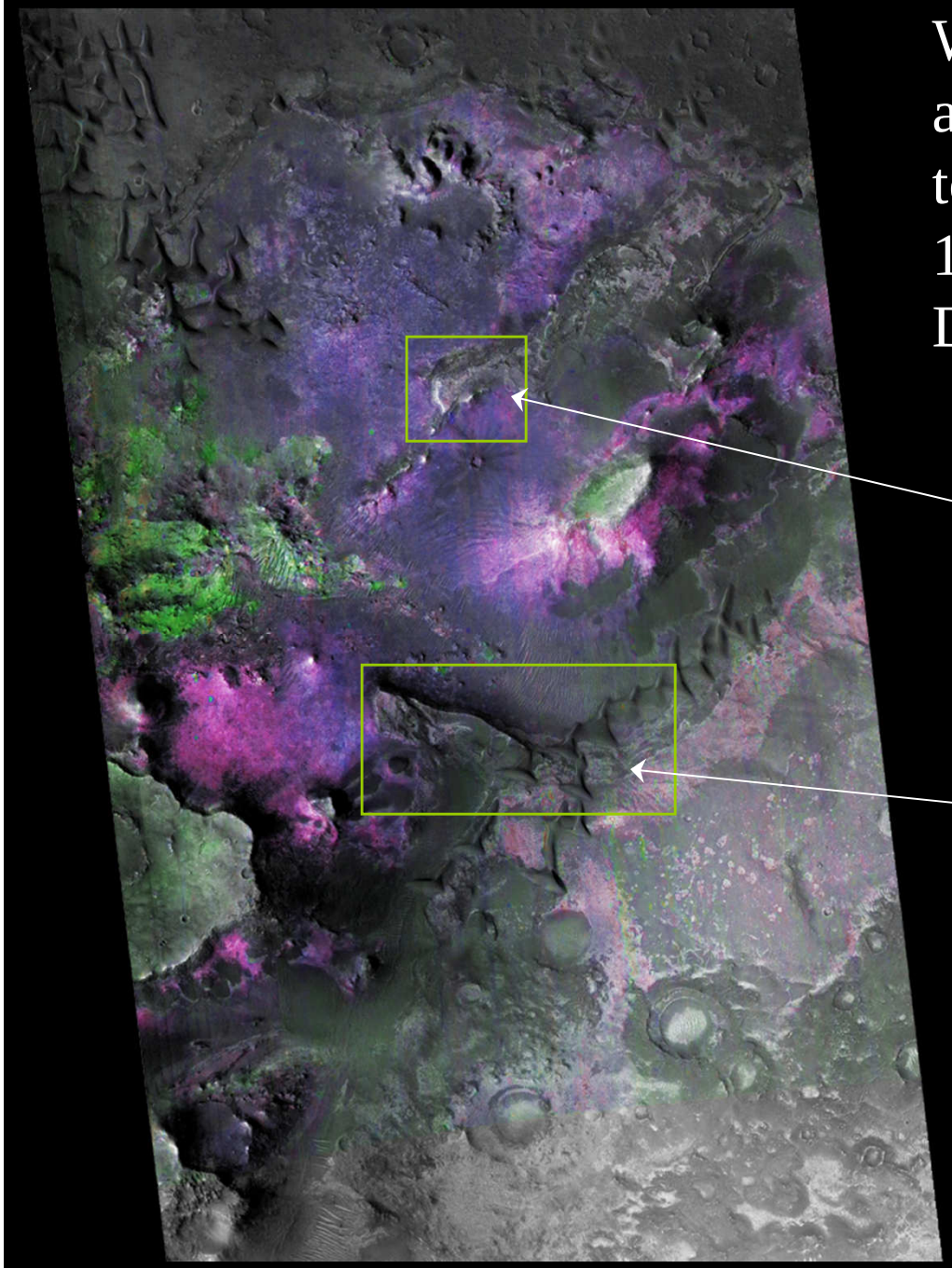
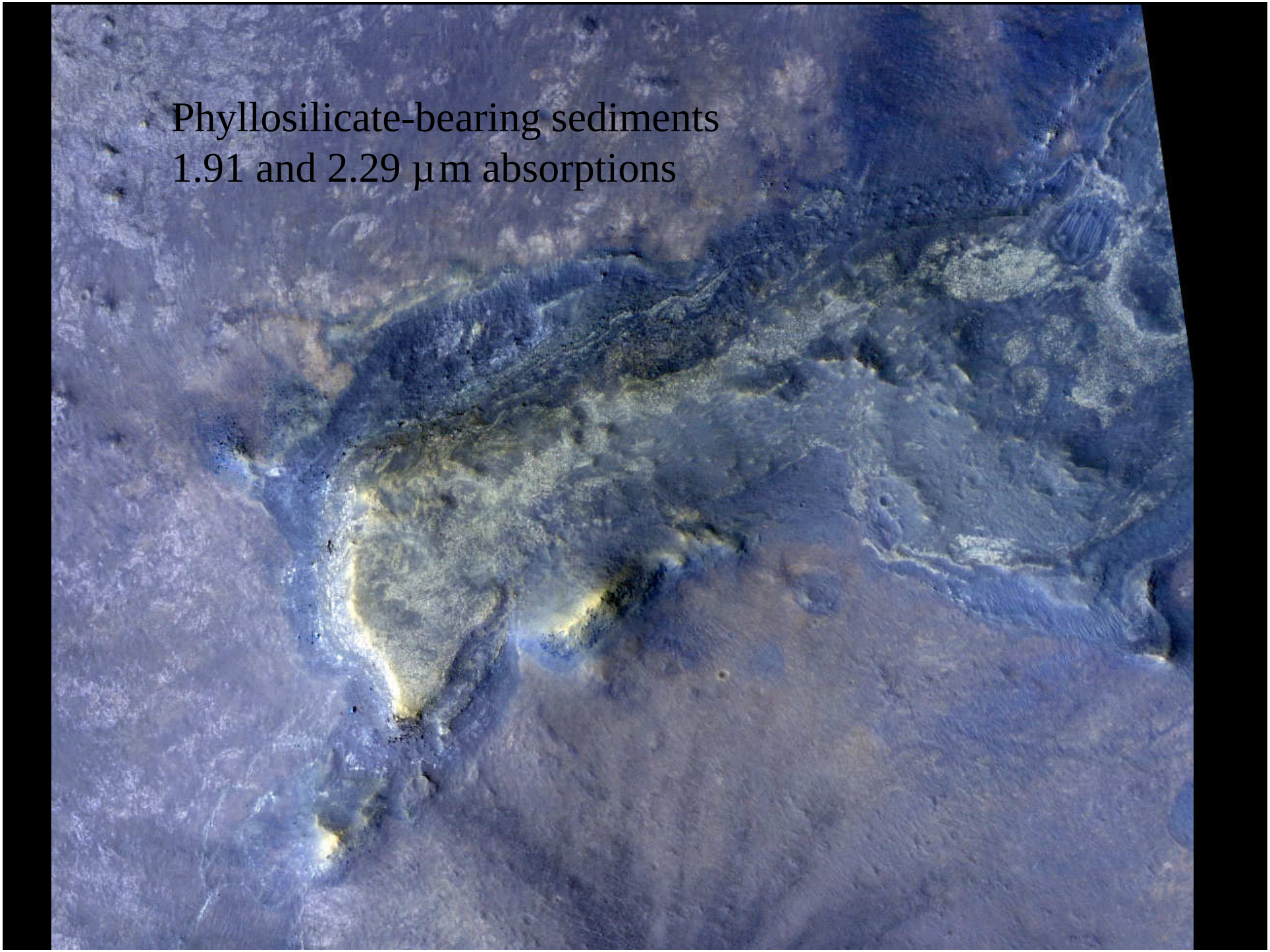


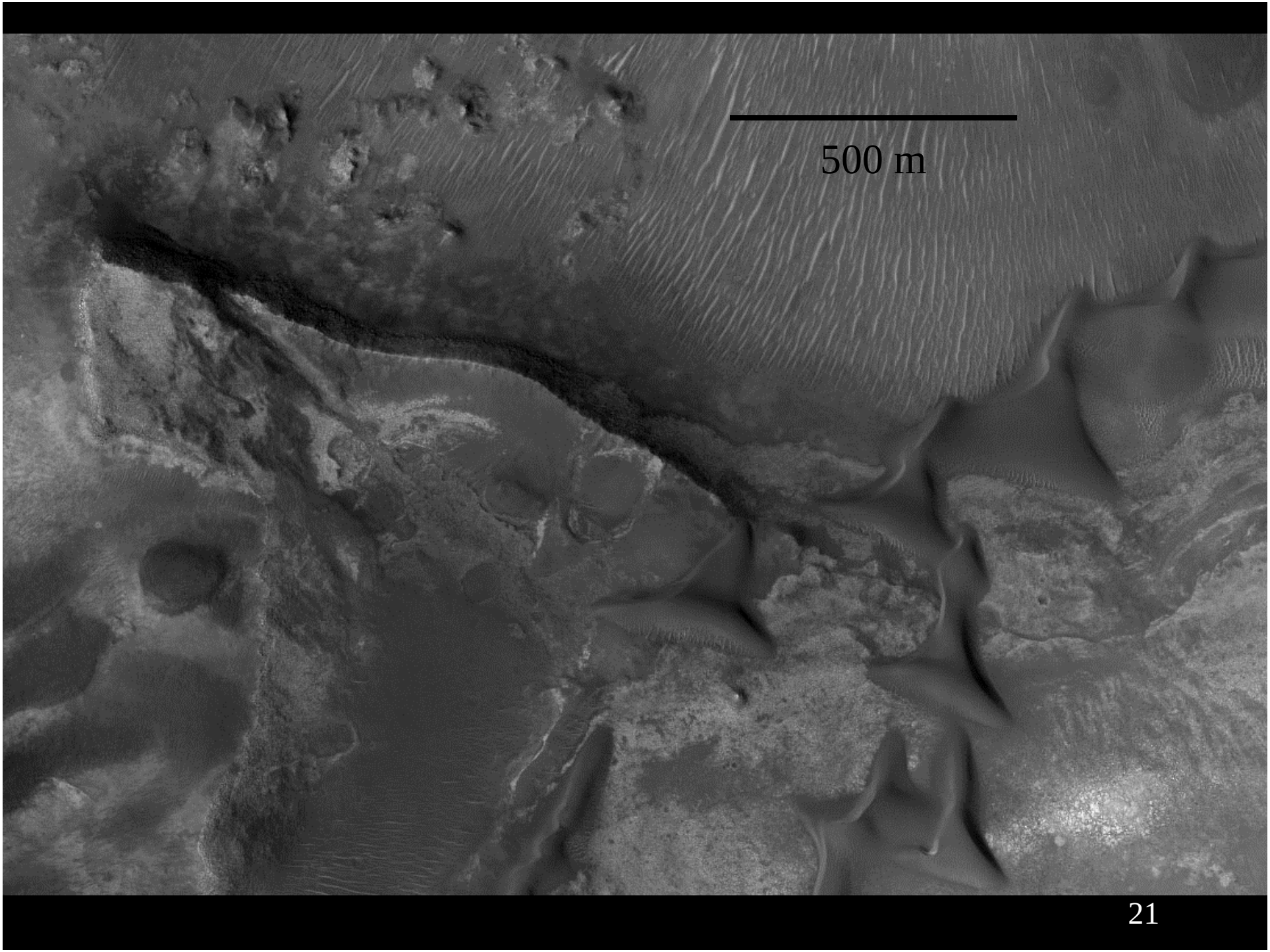
Widespread gradation by alluvial and fluvial processes has filled in topographic lows
1 km thickness in impact craters
Deposited in Nili Fossae troughs

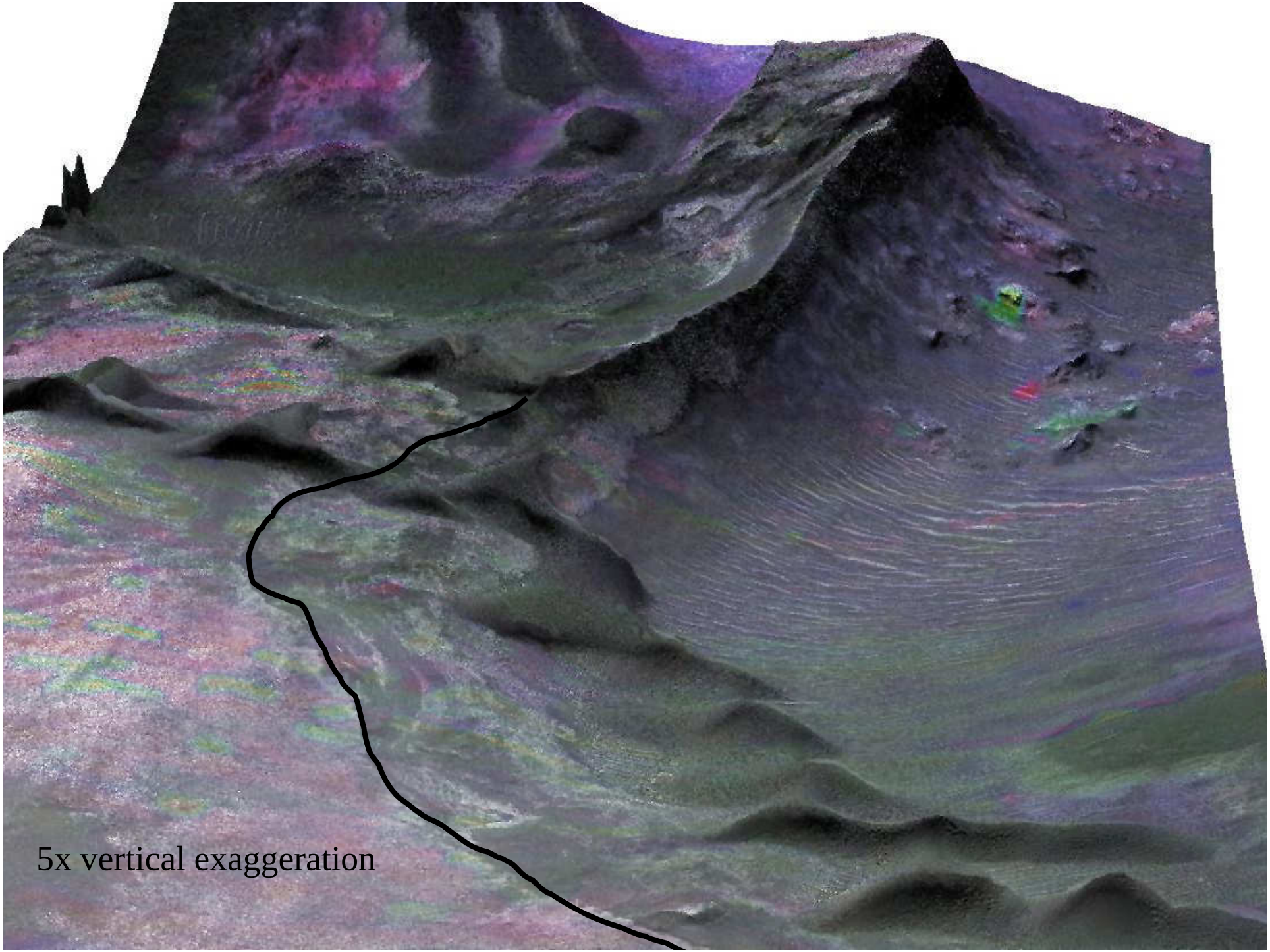
Layered material on the floor of the sapping channel

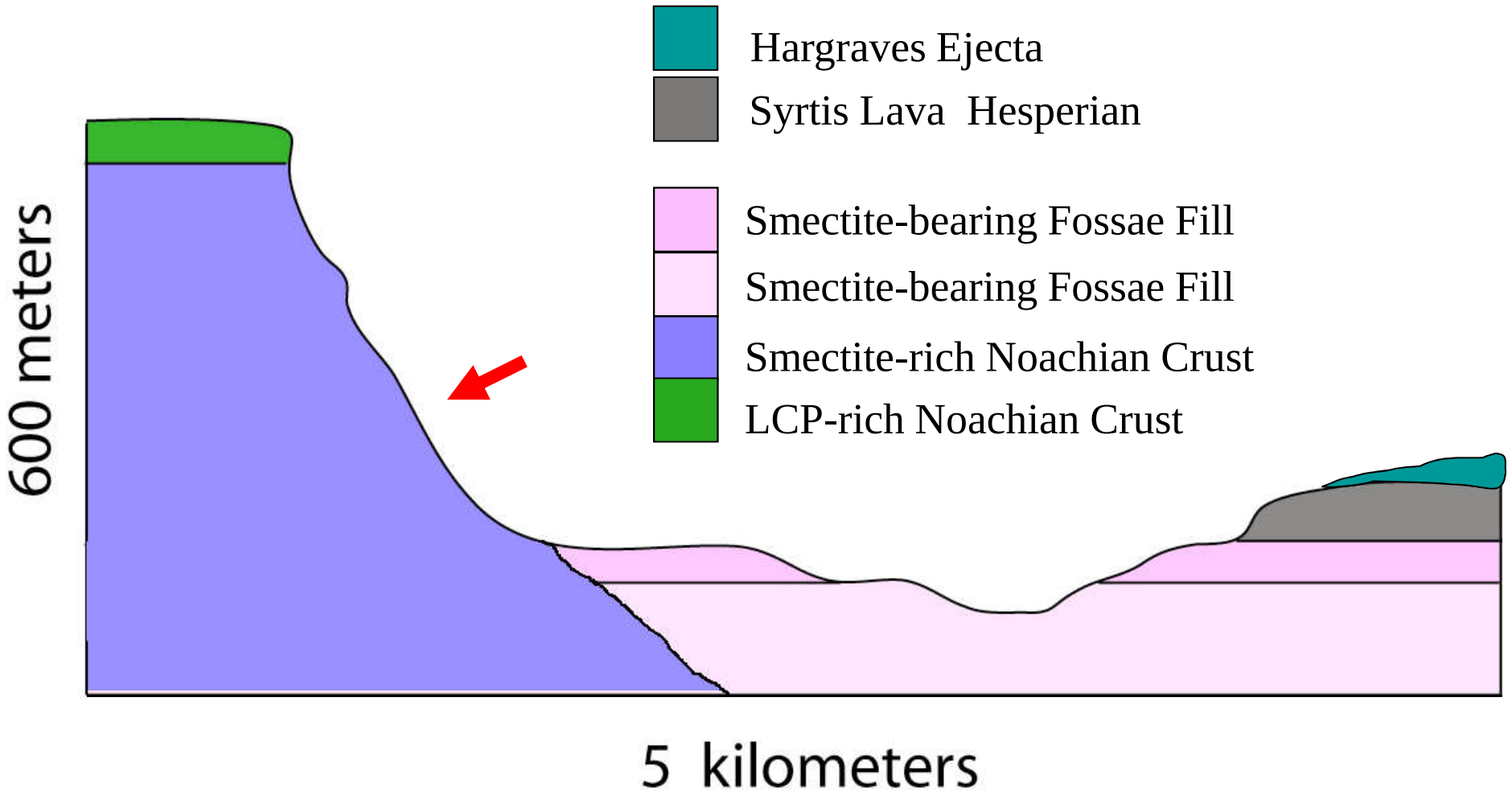
Trough fill

Transported phyllosilicate-bearing alluvial/fluvial deposits in the go-to site


Phyllosilicate-bearing sediments
1.91 and 2.29 µm absorptions


500 m


5x vertical exaggeration



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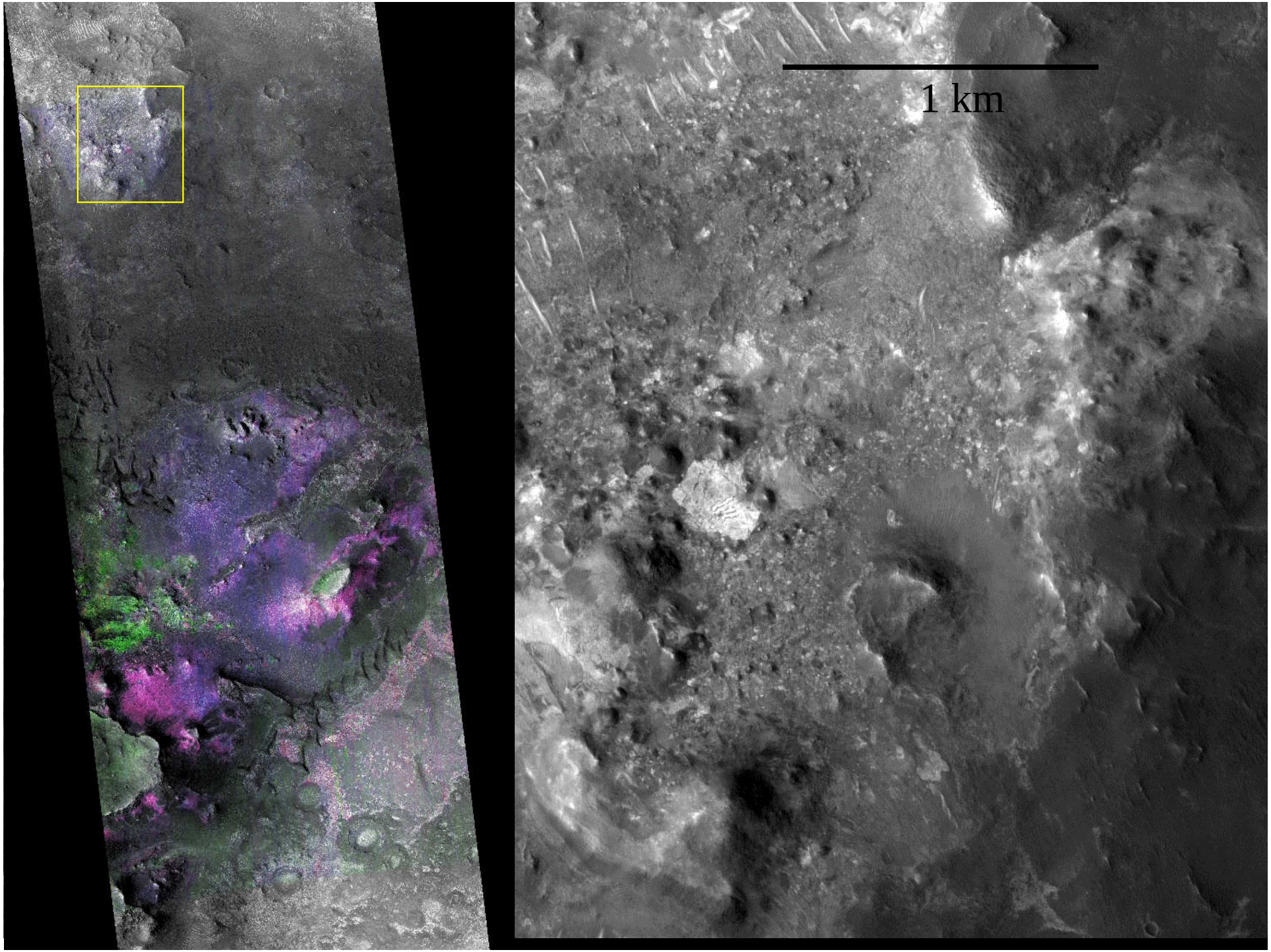
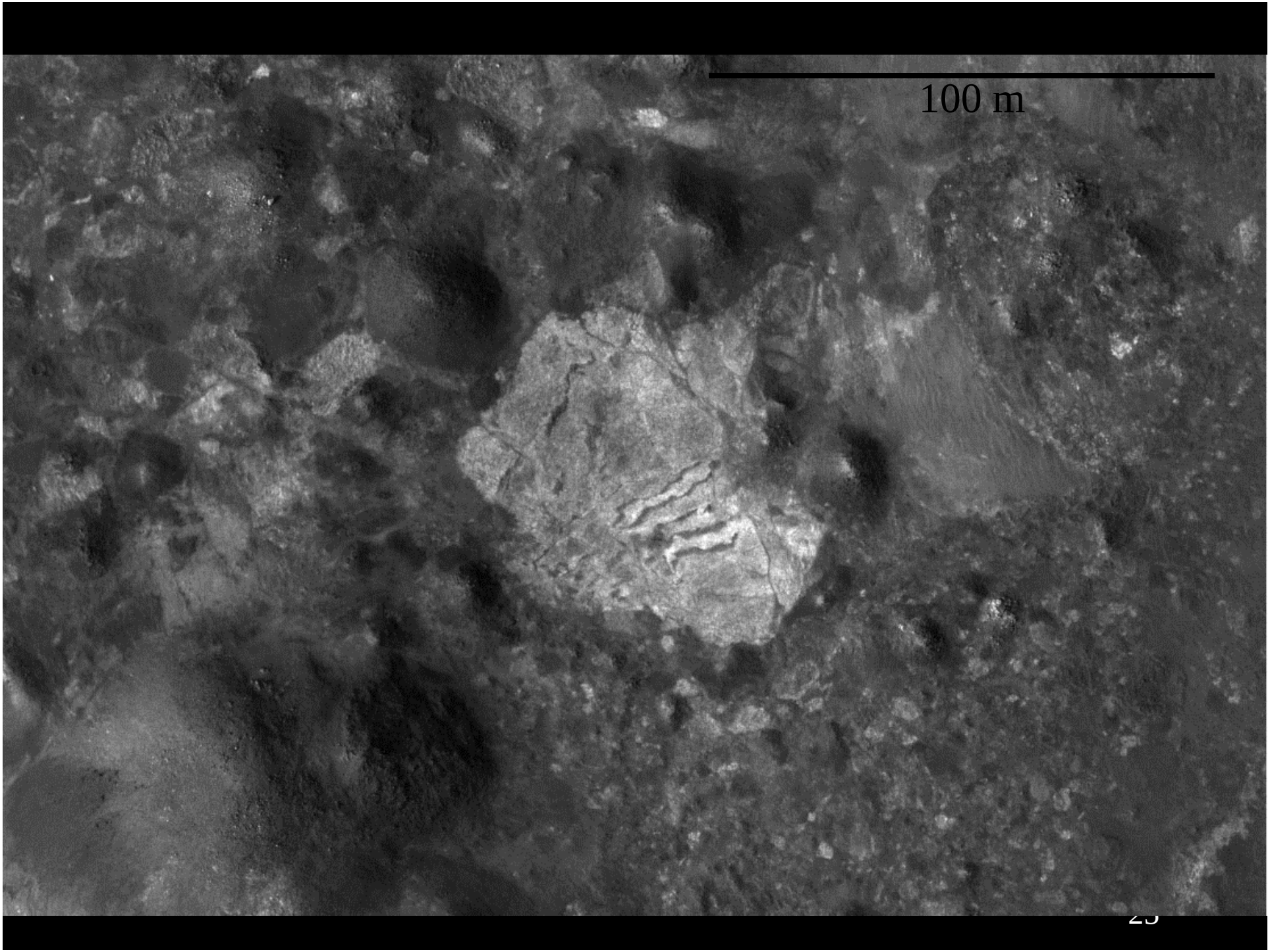
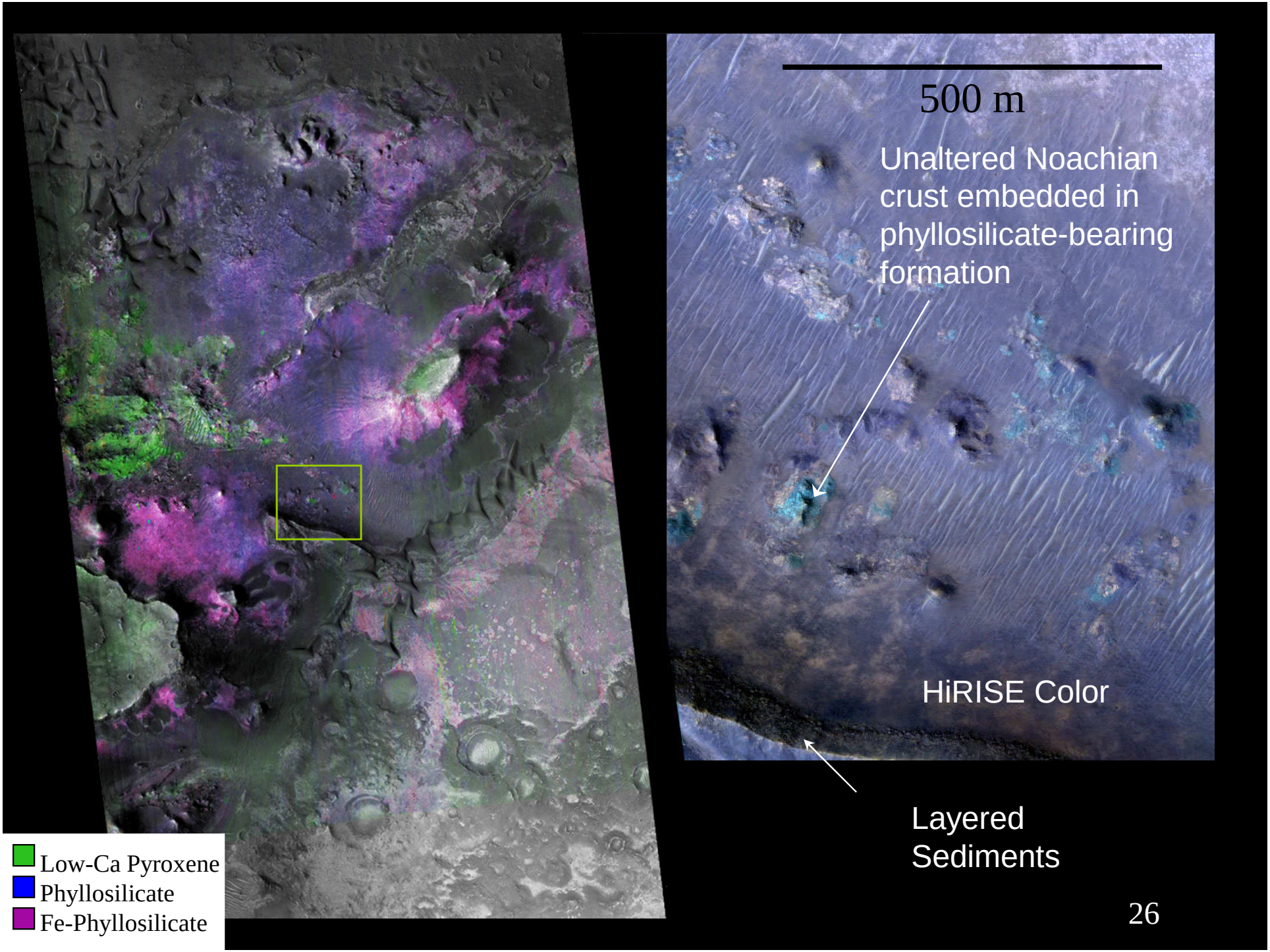
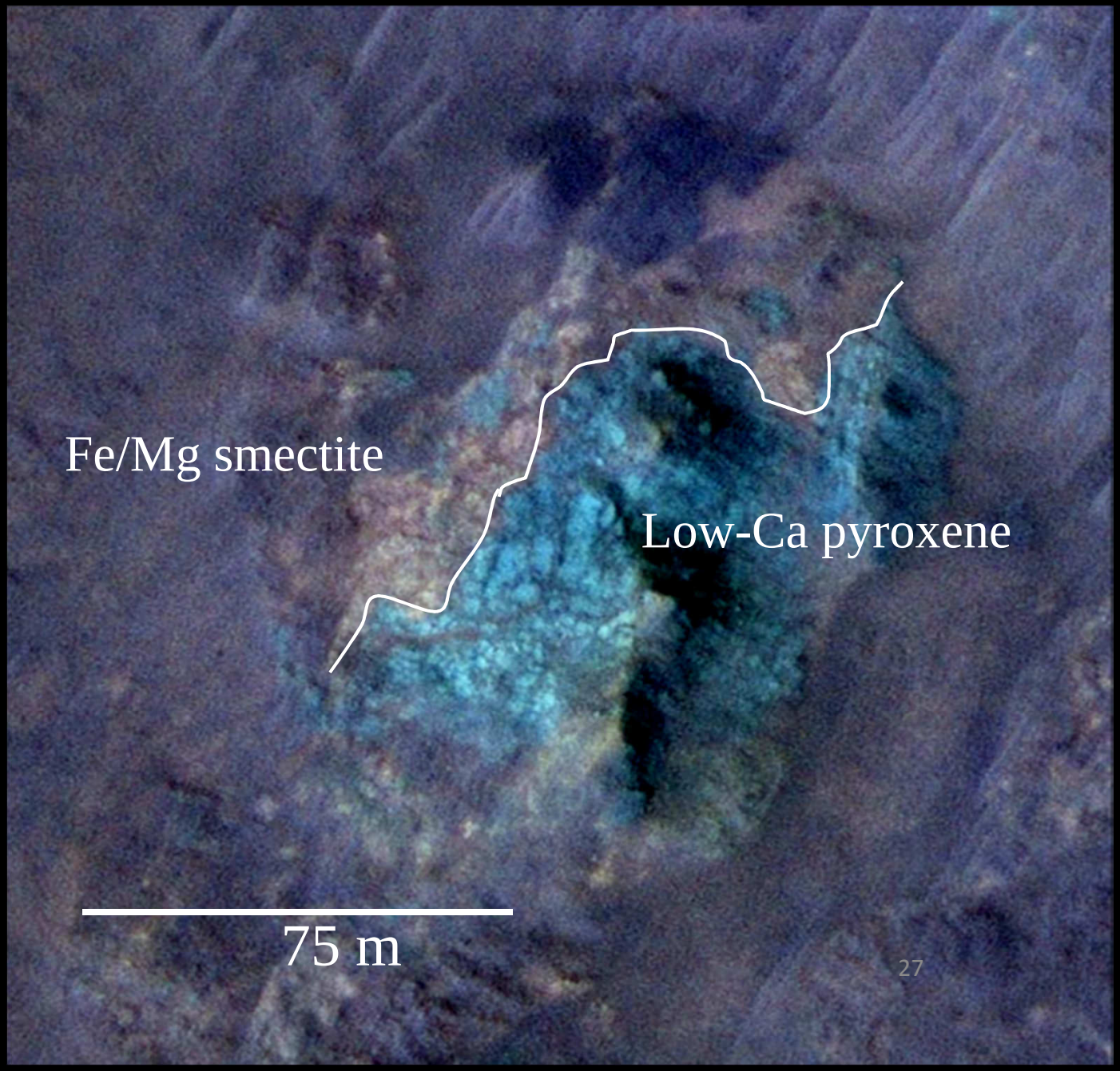
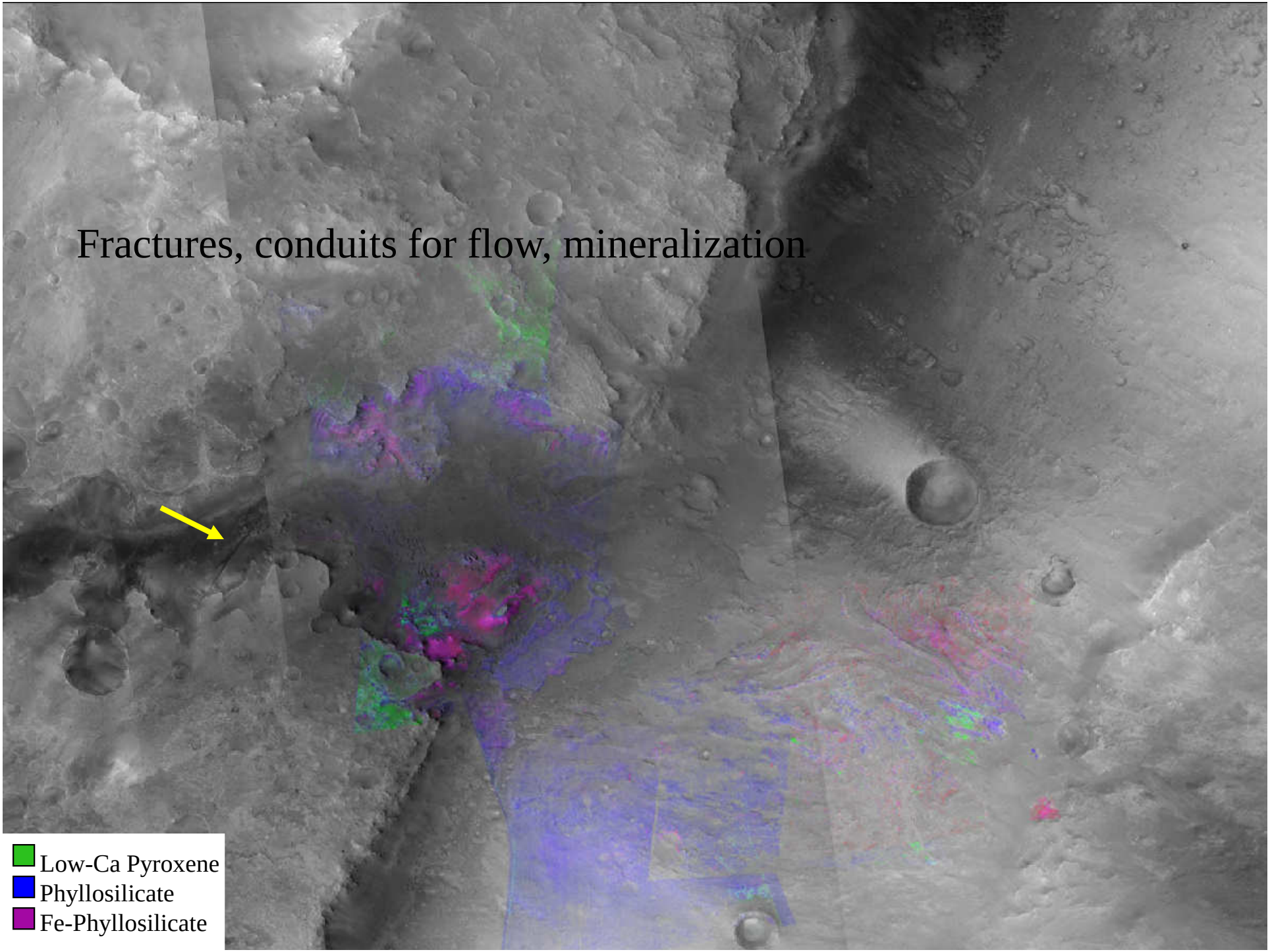
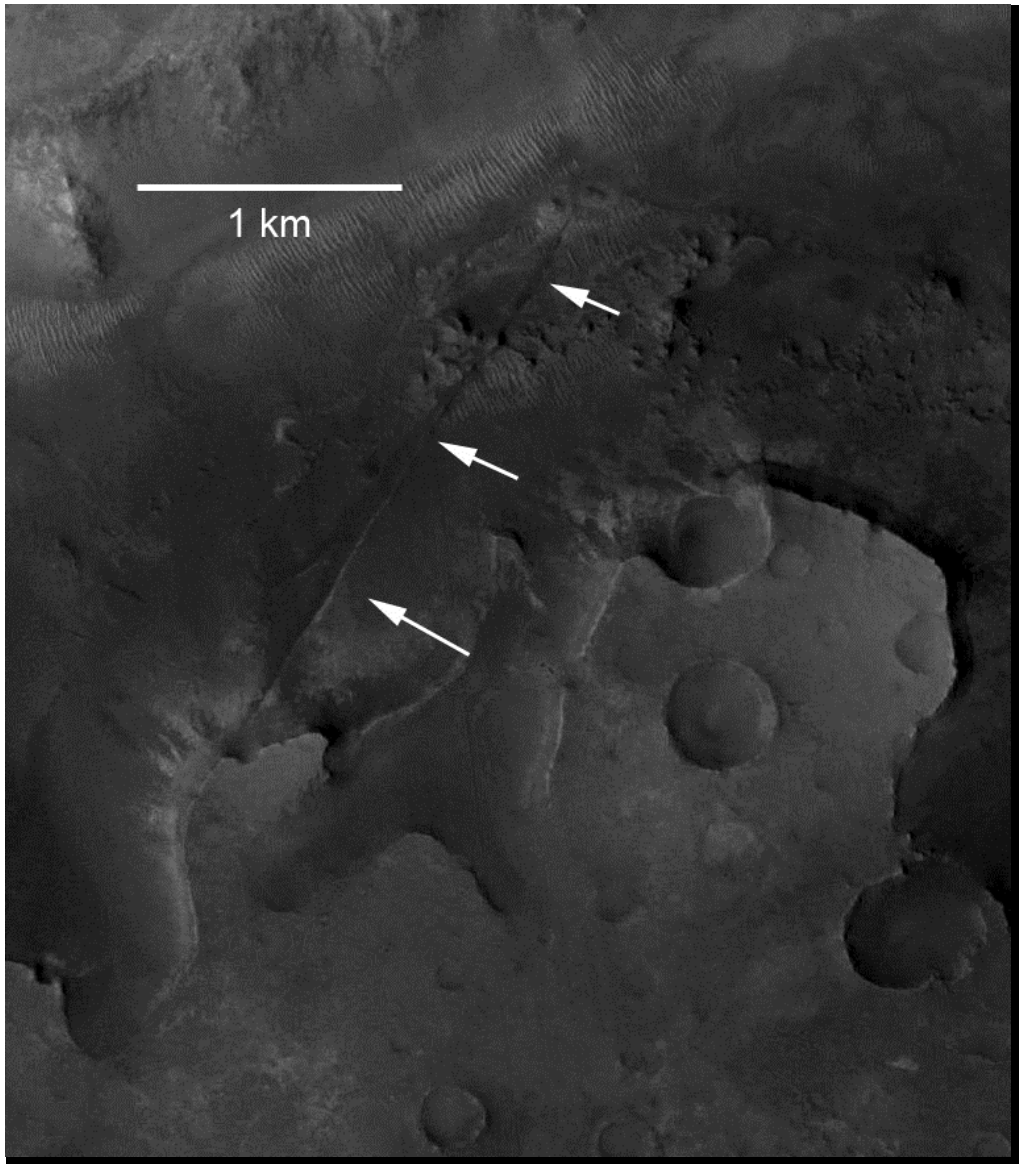

1 km

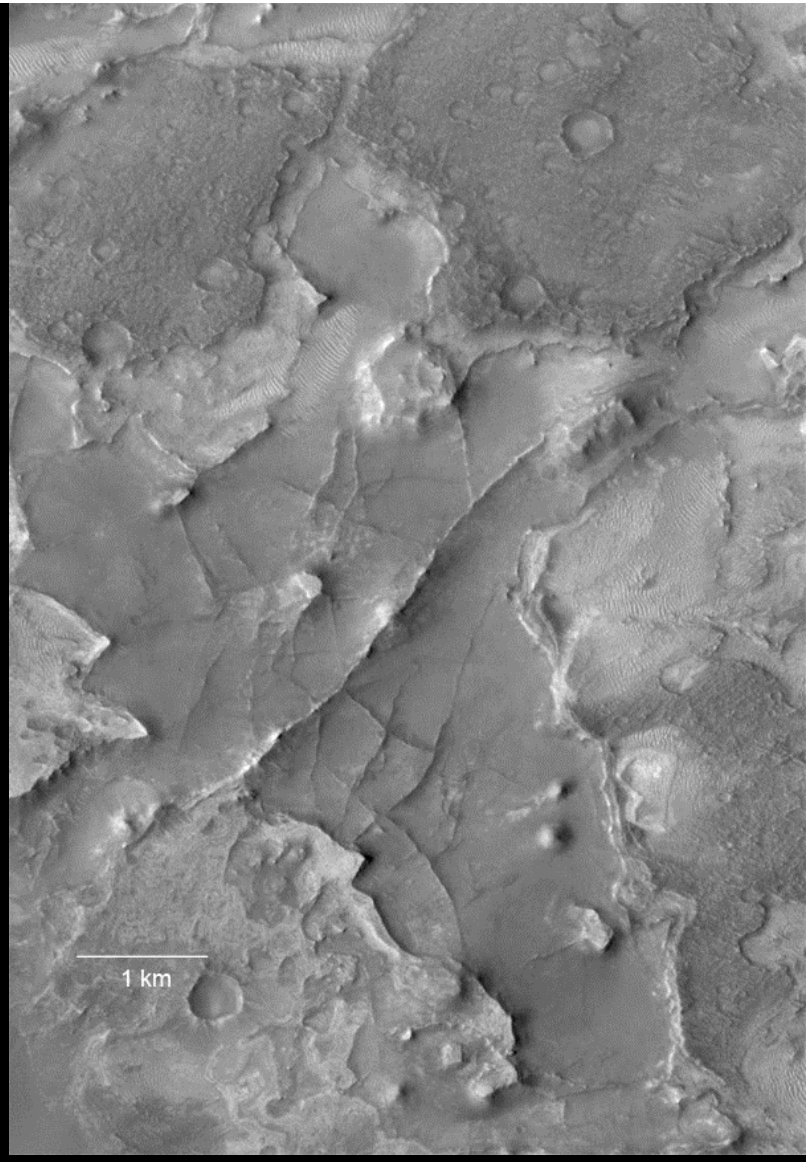

100 m


500 m
Unaltered Noachian crust embedded in phyllosilicate-bearing formation
HiRISE Color
Layered Sediments
Low-Ca Pyroxene
Phyllosilicate
Fe-Phyllosilicate


Fe/Mg smectite
Low-Ca pyroxene
75 m
27


Fractures, conduits for flow, mineralization
Low-Ca Pyroxene
Phyllosilicate
Fe-Phyllosilicate


1 km


1 km

Nili Fossae Trough

- Diverse habitable environments mitigates against a limited or pre-judged suite of environments
- Broader science goals advance understanding of Mars as a planet
- Diverse Noachian environments present throughout the landing site
- Regional geologic context, represented in the landing site, indicates sustained interaction of water with the crust as a consequence of multiple episodes of distinct character
  - Fe/Mg Phyllosilicates with variation in band position, strength of water absorption
  - Smectite clay transported and deposited in fluvial systems
  - Regional episode of kaolinite formation
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- The region north east of Syrtis Major was persistently wet and the geologic context for understanding the interaction of water is extraordinarily well preserved and exposed